Coleoptera from Hen Island (Taranga), Northland, New Zealand

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ABSTRACT

The topography and vegetation of Hen Island are briefly described. Some indication is given of the difficulties involved in determination of New Zealand beetles. Systematic, distributional and ecological notes, where relevant, are included under the name of each species in the species list.

Geographical distribution is discussed and it is concluded that fairly widespread common species predominate. The relationships of the fauna appear to be with that of the mainland opposite. The origin of the fauna is discussed and it is concluded that there have been several immigrations from the mainland during low sea-levels of the Pleistocene. The water barrier is apparently not sufficient to prevent active or passive migration of most species across it. This results in many cases in a continuous flow of genes from the mainland populations, preventing divergence of the island populations. Some island populations of wingless species appear to have diverged slightly.

Hen Island is of value as a sanctuary in that it provides natural habitats for rare species of animals which may become extinct on the mainland.

INTRODUCTION

Hen Island (Taranga) is situated 64 miles north of Auckland and about twelve miles east of Ruakaka Beach. The main axis is east-west and the island extends for three miles in this direction, varying in width from 2 chains to over one mile. A sharp central ridge extends along the axis and is roughly 1000 feet high for much of its length, rising to a number of andesitic pinnacles, the highest of which is 1420 feet, in the western part of the island.

Hen Island is a wild life sanctuary and is completely clothed in forest in varying stages of regeneration. The forest is mainly coastal (Type Q1 of McKelvey and Nicholls, 1957) with such species as Pohutukawa *(Metrosideros excelsa)*, Karaka *(Corynocarpus laevigatus)*, Puriri *(Vitex lucens)* being fairly plentiful. The northern side of the central ridge is covered mainly with Kanuka *(Leptospermum ericoides)* forest (Type R1 of McKelvey and Nicholls, 1957) with many other associated species. For a more detailed account of topography and vegetation see Cochrane (1954) and Cranwell and Moore (1935).

Collecting was confined to the western part of the island and covered two major types of habitat, these being the more or less typical coastal forest on the southern side of the main ridge and the more exposed forest on the summit and northern side of the ridge. The latter habitat was more productive in numbers of species, especially types normally found in places exposed to the sun, as would be expected.

Most beetles are found in fairly restricted habitats, many being confined to particular food plants, others occurring only under loose bark, logs, in rotten wood etc. Consequently, considerably more detailed information than the general type of forest habitat in which a species occurs, is necessary for the data to be of much ecological value. In the species listed below such information, when available, is noted for each species. No leaf mould or fresh water collections were made, but most other types of habitat were examined.

SPECIES LIST

The following species list includes all specimens collected by the present writer, and specimens collected by Mr. E. G. Turbott in the Coleoptera Collection of the Auckland Museum.

Where species have been identified by comparison with authentically determined specimens, chiefly from the Broun Collection (of which a few specimens are in the Auckland Museum Coleoptera Collection) then checked with the original descriptions, this is stated. In most cases, however, the specimens have been identified from the original descriptions alone. As Broun, who described the vast majority of New Zealand beetles, very rarely used keys or illustrations in any of his works, and the types of all except a very few of the species are in the collections of the British Museum, this task has not been easy. In some of the larger and more difficult genera the descriptions are not always adequate for the accurate discrimination of similar species, while in other cases a species has been described under two or more names. It frequently happens that the synonymous descriptions are more comprehensive than the earlier description of the same species, which generally results in specimens receiving the synonymous name when identified by reference to descriptions alone.

More serious is the possibility that an undescribed species may be determined as a similar previously described species, or that of two closely related inadequately described species, the wrong name may be applied to the specimens concerned. In cases where the identity of a species is in doubt, for any of the above reasons, this is stated.

Notes on distribution, ecology and systematics are included for many of the species. The superfamily and family classification followed is that of Crowson (1955).

Unless otherwise stated all specimens were collected during the Auckland University Field Club Scientific Camp of May, 1956, by the present writer. All Hen Island specimens of each species listed are at present in the writer's personal collection unless a statement to the contrary is made. Duplicates will eventually be placed in the Auckland Museum Collection.

SUBORDER ADEPHAGA

SUPERFAMILY CARABOIDEA

Family CARABIDAE

Subfamily CICINDELINAE

Cicindela tuberculata Fabr.

One specimen collected by E. G. Turbott, May, 1949; no further data. Specimen in Auckland Museum Collection. This species is widely distributed and fairly common.

Subfamily HARPALINAE

Ctenognathus bidens Chaudoir.

Two specimens amongst leaf mould and other debris in a small Nikau grove, south coast. Determined by comparison with specimens from Warkworth and Great Barrier Island identified by Dr. E. B.

Britton, British Museum (Natural History). This species is found frequently under logs in the vicinity of Auckland and most of Northland and also occurs on Little Barrier Island, but not apparently on the Poor Knights Islands.

Ctenognathus novaezelandicus Chaudoir.

Three specimens under boulders on boulder beach in the "supralittoral fringe". Identified by comparison with specimens from near Bethels Beach, Great Barrier Island and Tawhiti Rahi, Poor Knights Islands, determined by Dr. Britton. This species is widely distributed in the Auckland Province, occurring at least as far north as Russell and the Poor Knights Islands, as far south as Port Waikato and east on the Coromandel Peninsula. The present writer has never found it more than about two miles inland. *C. novaezelandicus* and *C. bidens* occur near Bream Head with another species *C. cardiophorus* Chaudoir.

SUBORDER POLYPHAGA

SUPERFAMILY HYDROPHILOIDEA

Family HYDROPHILIDAE

Cyloma lawsonus Sharp.

Two specimens beaten from karamu *(Coprosma robusta)*. This species occurs at Tairua and Whangarei Heads (Broun, 1880), and appears to be rare, although this could well reflect lack of collecting in suitable habitats

SUPERFAMILY SCARABAEOIDEA

Family SCARABAEIDAE

Subfamily MELOLONTHINAE

Odontria xanthosticta White.

One specimen taken at light, camp. Also in the writer's collection are two specimens collected on Marotiri (Big Chicken) by E. N. Milligan in August, 1955. Specimens identified by Mr. B. B. Given, Entomology Division (D.S.I.R.), Nelson. This species has been found by the present writer at Whangarei Heads, Papatoetoe, Great Barrier Island, Poor Knights Islands, and at other localities near Auckland. The Great Barrier specimens were flying in November, the Poor Knights specimen in January. Given (1952) states that "this species appears to fly during the autumn and winter". *O. xanthosticta* apparently also flies during late spring and summer. It is possible that the season when the adults are flying begins earlier on offshore islands, but, as stated above, the adults have been found flying during May and August on the Hen and Chickens group. Perhaps the flying season is extended on offshore islands by the more equable year-round climate compared with the mainland. *O. xanthosticta* appears to be coastal in habitat (Given, 1952). This is supported by the collecting records of the present writer.

SUPERFAMILY ELATEROIDEA

Family ELATERIDAE

Corymbites sp.

A final instar elateroid larva was dug out of soil, south coast, and enclosed with some earth in a collecting tube. This was re-examined in

February, 1957, when an adult beetle was found to have emerged. Unfortunately it disintegrated on touch, thus making specific determination impossible.

SUPERFAMILY BOSTRYCHOIDEA

Family PTINIDAE

Ptinus speciosus Broun.

One specimen beaten from flower of *Senecio kirkii* on main ridge near "Old Man" pinnacle, about 1000 feet. Hudson (1934) states that it is — "Found amongst Kiekie *(Freycinetia)* but apparently rare." There is one specimen in the writer's collection from Tawharanui, near Matakana.

SUPERFAMILY CLEROIDEA

Family TROGOSITIDAE

Leperina nigrosparsa (White.)

One specimen collected by E. G. Turbott, May, 1949; no further data; in Auckland Museum Collection. Determined by comparison with specimen from Broun Collection. The insect is relatively small (10 mm. total length), but otherwise agrees with the description and the Broun specimen. The species is quite variable in size (10-16 mm.) and is the most distinctive of the New Zealand species. It has been found occasionally near Auckland and at Wellington; according to Hudson (1934) it occurs under bark. It has been collected from a fallen Nikau sheath on Little Barrier Island by the writer.

Leperina brounii Pasc.

One specimen under loose bark of Pohutukawa *(Metrosideros excelsa)* on south coast. Determined by comparison with specimen from Broun Collection. This species is the *Leperina wakefieldi?* Sharp of Watt (1957). Further material obtained since the former paper was written has satisfied the writer that the Great Barrier specimen, along with specimens from Tawharanui, near Matakana, Noises Islands, Poor Knights Islands and Horuhoru Island all belong to the one variable species, *L. brounii*. The size range is 6.5-10 mm. and individuals also vary in the intensity of punctation on the head and pronotum. The shape of the pronotum seems to be one of the most reliable characters for separating species of this genus, but unfortunately none of the original descriptions are illustrated. *L. brounii* generally occurs under the loose bark of Puriri *(Vitex lucens)* and Pohutukawa; Broun found the type specimen under the bark of Ngaio *(Myoporum laetum)* at Tairua, on the east coast of the Coromandel Peninsula north of Waihi (Broun, 1880).

SUPERFAMILY CUCUJOIDEA

SECTION CLAVICORNIA

Family NITIDULIDAE

Epuraea zealandica Sharp.

One specimen beaten from Taupata *(Coprosma retusa)* on south coast, one specimen in base of fallen Nikau leaf in Nikau *(Rhopalostylis sapida)* grove, near south coast. Determined by comparison with specimen from Broun Collection. Of the three native species in the genus

E. signatum Broun is the most comprehensively described and the type is stated by Broun (1880) to have been found on the Nikau at Whangarei Heads. Specimens from Mount Manaia, Moumoukai Valley and Bethels Beach, found in fallen Nikau leaves, all agree with the description of *E. zealandica*. It is not clear from the descriptions in what respects *E. zealandica* differs from *E. antarctica* White. It is possible that one or both of these species are synonyms of the extremely inadequately described "*Nitidula*" *lateralis* White (1846).

Family CRYPTOPHAGIDAE

Telmatophilus nitens Sharp.

One specimen beaten from Taupata *(Coprosma retusa)* on south shore, one beaten from flower of *Senecio kirkii* on ridge near "Old Man" pinnacle, about 1000 feet. Determined from description. Two specimens labelled "*Telmatophilus nitens*, Broun Coll." in the Auckland Museum Collection were found to be the allied species *T. depressus* Sharp.

In the present writer's collection there are specimens of *T. nitens* from Horuhoru beaten from Taupata (*?Cryptophagus* sp. of Watt, 1956), and a long series from the Poor Knights Islands (beaten from Taupata and *Carmichaelia* sp.). The type locality is Auckland and Hudson (1934) states that it is abundant in the flowers of speargrass during November near Wellington.

"Cryptophagus" rutilus cf. Broun.

Fourteen specimens beaten from Kanuka *(Leptospermum ericoides)* on main ridge, about 1000 feet. This is a small species (1.5 mm. in length). It appears to be identical with the species from Mayor Island (Watt, 1957). Mr. R. A. Crowson has stated (personal communication) that the New Zealand species do not belong to the genus *Cryptophagus*.

Family CORYLOPHIDAE

Sacina? sp.

Three specimens beaten from lichen-covered Pohutukawa on summit of highest pinnacle (1420 feet).

Family COCCINELLIDAE

Scymnus flavihirtus Broun.

One specimen beaten from Karamu *(Coprosma robusta)* on flat, south coast. This species is fairly variable and it is possible that there are two very similar species included under the one name by Broun as varieties. A revision of the native ladybirds is required when sufficient material has been collected. Specimens from the crater of Mayor Island were incorrectly determined as *?S. suffusus* Broun (Watt, 1957), which is a considerably smaller species than *S. flavihirtus*.

Scymnus acceptus Broun.

One specimen beaten from Taupata *(Coprosma retusa)* on south coast. Hudson (1934) states that this species is —"one of the commonest species of Coccinellidae in New Zealand", and figures the larva and adult.

Scymnus minutulus cf. Broun.

One specimen beaten from flower of *Senecio kirkii* on main ridge, about 1000 feet. The specimen is not *Stethorus bifidus* Kapur (1948), and agrees reasonably well with Broun's description of *S. minutulus.* Broun (1880) states that he found his specimens at Tairua and Whangarei Heads.

Family LATHRIDIIDAE

Corticaria sp.

One specimen beaten from Karamu *(Coprosma robusta)* on main ridge at about 1000 feet.

SECTION HETEROMERA

Family TENEBRIONIDAE

Cilibe elongata Brême.

One specimen in sleeping bag, camp, one specimen under stone, Marotiri Island ("Big Chick") collected by E. N. Milligan, August, 1955.

This species is the *C. humeralis* Bates of Watt (1956 and 1957) which latter apparently is found only near Wellington. *C. elongata* occurs frequently on most of the northern offshore islands, often being associated with *Muhlenbeckia complexa.*

Geographical variation in *C. elongata* will be discussed in detail in a revision of the genus at present in preparation. The 2 specimens from the Hen and Chickens resemble individuals from Ruakaka Beach to the west of the islands, but are more strongly sculptured. They fall within subspecies *elongata.*

Chrysopeplus expolitus (Broun.)

Three specimens cut from rotten log. *Chrysopeplus* is a *nomen novum* for *Leiopeplus* Broun nec Har. (Gebien, 1942). This species is fairly generally distributed on the east coast north of Auckland and on the offshore islands of this area. (Type locality Whangarei Heads; specimens in Auckland Museum Collection from Parua Bay, Mahurangi Heads, Cavalli Islands, Noises Islands; specimens in the writer's collection from Poor Knights Islands, Noises Islands, Rangitoto, Little Barrier Island, Warkworth, Tawharanui.) It occurs in rotten wood and under the loose bark of Pohutukawa *(Metrosideros excelsa)* and Puriri *(Vitex lucens). C. expolitus* appears to be a strictly coastal insect, not having been found more than a quarter of a mile from the sea by the present writer.

Family ALLECULIDAE (=CISTELIDAE)

Xylochus dentipes aff. Broun.

One female specimen on *Collospermum* on "Three Rocks" Pinnacle at about 1000 feet. In this genus it is necessary to have male specimens available for specific determination. The Hen Island specimen differs slightly from female *X. dentipes* from Rangitoto (found associated with males) and it is possible that it is the female of *X. spinifer* Broun. (Type locality: Moko Hinau Island.) Unfortunately no male specimens of *X. spinifer* are available to the present writer so the determination must remain in doubt until the female of the latter species can definitely be associated with the male.

Judging from the descriptions *X. tibialis* Broun is probably the male of *X. substriata* Broun, especially as the types of both "species" were found at Tairua (Broun. 1880).

Family SALPINGIDAE (=Pythidae in part)

Salpingus perpunctatus Broun.

One specimen beaten from Karaka *(Corynocarpus laevigata)* on main ridge. Determined by comparison with specimen from Broun Collection. According to Hudson (1934) this species may be generally distributed, at least in the North Island.

SUPERFAMILY CHRYSOMELOIDEA

Family CERAMBYCIDAE

Subfamily CERAMBYCINAE

Epheus costifer Broun.

One specimen in Nikau grove, resting on trunk of palm. This specimen agrees perfectly with Broun's description. It appears to be larger than normal, however (total length 24 mm.). The length quoted by Broun (presumably of the holotype) is 20 mm. and the range quoted by Hudson (1934) is 15-20 mm. Many species of cerambycids are extremely variable with regard to size. Hudson states that *E. costifer* is "a rare and beautiful species, so far only known from Wellington, Tuakau and Kaeo".

Subfamily LAMIINAE

Xylotoles griseus (Fabr.)

Two specimens beaten from Karamu *(Coprosma robusta),* two specimens on tent wall at night, one specimen on grass, one specimen beaten from *Nothopanax arboreum* (ridge, about 1000 feet), three specimens collected by Mr. E. G. Turbott, May, 1949, in Auckland Museum Collection. Determined from revision of Breuning (1950). Some specimens of this species might key out as *X. lynceus* (Fabr.), but in the latter species the third antennal segment is distinctly longer than the fourth, while in *X. griseus* these two segments are equal in length and there are several other distinguishing characters. This species occurs on Mayor Island *(X. griseus* and *Xylotoles* sp. of Watt, 1957), Noises Islands, Rangitoto, Poor Knights Islands (records from writer's own collection) and according to Broun (1880) it is "tolerably common in both the larger islands". *X. griseus* appears to be predominantly a coastal insect. The offshore island specimens show some geographical variation, but it is doubtful whether any are worthy of separate subspecific status.

Xylotoles aegrotus Bates.

Four specimens beaten from Taupata *(Coprosma retusa)* on south coast, two specimens beaten from Karamu *(Coprosma robusta)* on central ridge (about 1000 feet). These specimens key out to either *X. parvulus* Bates or *X. pygmaeus* Bates according to Breuning's key, but differ from both in the relative length of the third and fourth antennal segments which are equal in length (third longer than fourth in *X. parvulus* and *X. pygmaeus).* Breuning does not include *X. aegrotus* in his key but states in the description: "Très proche de *parvulus* White, mais avec le troisième article des antennes aussi long que le quatrième et les élytres plus densément ponctués jusqu'au milieu." *X. aegrotus* occurs on various local offshore islands and in coastal habitats on the mainland near Auckland.

Xylotoles nanus Bates.

One specimen beaten from *Coprosma robusta* on flat on south coast. This species, like the two preceding, is relatively common on offshore islands and the coast of the mainland near Auckland.

Family CHRYSOMELIDAE

Subfamily GALERUCINAE

Luperus vulgaris Broun.

One specimen beaten from flower of *Senecio kirkii* on main ridge (about 1000 feet). The present writer has no hesitation in determining this specimen as *L. vulgaris* in spite of the large number of similar species in the genus. A fairly long series in the writer's collection shows a considerable range of variation. Due to the soft integument the elytra of this species sometimes fold over latero-posteriorly and each apex comes to a point when mounted. This results in a shape precisely that described by Broun (1880) in his description of *L. attenuata*. There appears to be nothing in the descriptions of *Luperus thoracica* Broun and *L. nigripes* Broun differentiating these species from variants of *L. vulgaris*. The types are all, however, in the British Museum (Natural History) so it is not possible to check the suspected synonymy at the moment. *L. vulgaris* is common on flowering plants, especially Rangiora *(Brachyglottis repanda)*, from August to October in the vicinity of Auckland.

SUPERFAMILY CURCULIONOIDEA

Family CURCULIONIDAE

In the absence of a satisfactory subfamily classification of this family, that set out in the Systematic Index of Hudson (1934) has been followed, with the exception of Subfamily Eugnominae (see Marshall, 1938). The number of species of New Zealand weevils (about 1500 described) is great. This fact, together with what might well be called the taxonomic chaos of the local species of the family makes specific, and often generic, determination a matter of difficulty. Three species are not included in the following list at all for this reason.

Subfamily OTIORRHYNCHINAE

Catoptes sp.

One specimen beaten from Hangehange *(Geniostoma ligustrifolium)*, south coast.

Subfamily ERIRRHININAE

Praolepra sp.

Three specimens beaten from *Coprosma robusta* on ridge, about 1000 feet. These specimens do not agree with the descriptions of any of the described species, but are closest to *P. squamosa* Pasc. or *P. infusca* Broun (the description of the latter is inadequate). This species also occurs on the North Auckland Peninsula.

Neomycta rubida Broun.

One specimen beaten from Pohutukawa *(Metrosideros excelsa)*, highest pinnacle (1420 feet), one specimen beaten from *Coprosma robusta*, ridge (1000 feet). Determined by comparison with specimen from Broun Collection. Hudson (1934) states that this species is probably generally distributed in the North Island. The types were collected at Tairua on Pohutukawa (Broun, 1880).

Subfamily **EUGNOMINAE**

Tysius amplipennis Pasc.

One specimen beaten from flower of *Senecio kirkii*, one from Kohekohe *(Dysoxylum spectabile)*, south coast. This species is probably generally distributed throughout New Zealand (Hudson, 1934).

Stephanorrhynchus attelaboides (Fabr.)

One specimen collected by E. G. Turbott, May, 1949; in Auckland Museum Collection. This species occurs fairly frequently around Auckland.

Scolopterus penicillatus White.

One specimen beaten from *Senecio kirkii*, ridge, 1000 feet.

Scolopterus pectoralis Broun.

One specimen beaten from *Senecio kirkii*, ridge, 1000 feet. This species may be a synonym of *S. penicillatus*.

Pactola spp.

Three species, data as follows:—

(a) One specimen beaten from *Nothopanax arboreum*, ridge, 1000 feet.
(b) Four specimens beaten from *Dysoxylum spectabile*, ridge, 1000 feet.
(c) One specimen beaten from *Dysoxylum spectabile*, ridge, 1000 feet.

Subfamily **CRYPTORRHYNCHINAE**

Psepholax granulatus Broun.

One specimen collected by E. G. Turbott, May, 1949; in Auckland Museum Collection. Broun (1880) states that he cut some specimens of this species out of *Fagus* (presumably *Nothofagus)* at Tairua.

Mesoreda sp.

Three specimens collected by E. G. Turbott, May, 1949; in Auckland Museum Collection.

Tychanus sp.

One specimen beaten from *Coprosma robusta*, ridge, 1000 feet.

Acalles spp.

Three species, data as follows:—

(a) One specimen beaten from Pohutukawa, highest point (1420 feet).
(b) Three specimens beaten from *Nothopanax arboreum*, ridge (1000 feet).
(c) One specimen beaten from Kanuka *(Leptospermum ericoides)*, ridge (1000 feet).

Paranomocerus spiculus Redten.

One specimen beaten from flower of *Senecio kirkii*, ridge (1000 feet). Three specimens collected by E. G. Turbott, May, 1949; in Auckland Museum Collection. This conspicuous species, apparently rare, has been found at Tairua (Broun, 1880).

Subfamily **COSSONINAE**

Unless otherwise stated, the following species were determined from the revision of Broun (1908).

Sericotrogus subaenescens Woll.

Two specimens beaten from flowering *Senecio kirkii,* one from *Coprosma robusta,* ridge, 1000 feet, two specimens beaten from *Coprosma retusa,* south coast. Determined by comparison with specimens from Broun Collection. This species occurs frequently on various shrubs in coastal localities near Auckland and on Mayor Island (Watt, 1957).

Stenotrupis wollastonianum Sharp.

One female beaten from *Coprosma robusta,* ridge, 1000 feet. This remarkable species is common on *Rhopalostylis sapida* (Nikau) at Whangarei and Waitakere Ranges (Broun, 1908) and also occurs near Wellington.

Arecocryptus bellus Broun.

One male and four females in fallen Nikau leaf, south coast. This species is almost invariably associated with the Nikau *(Rhopalostylis sapida)* and appears to have the same distribution as that palm.

Arecophaga varia Broun.

Eight males and two females in fallen Nikau leaf, south coast. This species is apparently fairly rare; Broun (1908) states that it occurs at Parua and Hunua Ranges, on *Rhopalostylis sapida.*

GENERAL DISCUSSION

Distribution

The species included in the list above fall into a number of categories with regard to distribution as follows:—

1. Species common and generally distributed throughout the North Island, and in some cases, the South Island. (15 species.)
2. Species rare (although sometimes locally common) and generally distributed. (3 species.)
3. Species common and generally distributed in coastal habitats in the North Island. (4 species.)
4. Species common and confined, as far as is known, to North Auckland and/or the vicinity of Auckland. (8 species.)
5. Species rare and confined, as far as is known, to North Auckland and/or the vicinity of Auckland. (5 species.)
6. Species that it is not possible to classify satisfactorily into one of the previous categories with the available data. (13 species.)

This classification is, of necessity, somewhat arbitrary, as little is known of the geographical distribution of many New Zealand beetles. Further collecting will no doubt show that some have much wider ranges than at present known.

Despite these qualifications the preponderance of widely distributed species is clear. With regard to relative abundance common species dominate the list.

Relationships of the Fauna

The above species list includes only a fraction of the beetle fauna of Hen Island. Collecting has taken place only in May, when many species present probably do not occur in the adult stage. No leaf mould was examined, and some other habitats received little attention.

The writer's experience indicates that the species list contains a fairly representative sample of the common species normally occurring on northern offshore islands in the habitats examined, i.e. the shrub and small tree strata of coastal forest and scrub. Some less common species are also included. It should be emphasised, however, that the discussion of relationships is based on a sample of the beetle fauna, not on the beetle fauna as a whole. Further collecting may modify some of the conclusions drawn, but mainly with respect to that part of the fauna not discussed here.

As the majority of species collected on Hen Island are widely distributed, they provide no evidence of faunal relationships. The few remaining species indicate relationship with the fauna of North Auckland in the vicinity of Whangarei (type localities are either Whangarei Heads or Parua Bay). With regard to geology, topography, vegetation and probably also climate, the Whangarei Heads area is very similar to Hen Island. The distribution of many beetles is controlled more by ecological factors than by the presence or absence of relatively minor geographical barriers (a strait 12 miles wide in the case of Hen Island).

Of 43 species described by Broun (1893) from Moko Hinau Island or Fanal Island, not one is yet known to occur on Hen Island.

The present writer has collected over 100 species of Coleoptera from the Poor Knights Islands, including a number of undescribed species. The only species known to occur on both the Poor Knights Islands and Hen Island are fairly widely distributed.

The above evidence may reasonably be interpreted as indicating that the Hen Island beetle fauna, or at least that sample of it discussed here, is most closely related to that found in similar habitats on the east coast of the North Auckland Peninsula. No relationship with the endemic beetle faunas of the Poor Knights Islands and the Moko Hinau group is indicated by the available evidence. These conclusions are supported by the fauna of land Mollusca (Milligan, 1954 and 1957).

Dispersal of Terrestrial Animals to Islands

One of the most interesting problems associated with any particular island fauna is the possible method or methods by which the component species of such a fauna have arrived on the island from the nearest large body of land. The various means by which animals may be dispersed to offshore islands are tabulated below:—

1. Migration across land connections in the past between island and mainland. The land connections may be due to:
   (a) eustatic lowering of sea level associated with glaciation;
   (b) uplift of the intervening sea floor.
2. Chance dispersal by means of:
   (a) floating objects such as logs and vegetation rafts;
   (b) attachment to land birds, sea birds or possibly other flying animals;
   (c) floating on the surface of the sea.
3. Introduction by human agency, either by accident or by design.
4 In the case of winged animals, migration by flight. Migration may be a periodic (e.g. annual) event, or may be accidental, as a result of the flying animal being caught by strong offshore winds.

Evidence that Hen Island has been connected to the mainland at past times will be discussed below. The writer believes, however, that it is not necessary to postulate a land connection to explain the presence of most of the beetles collected. The water barrier separating Hen Island from the mainland is probably not sufficiently wide to prevent frequent accidental migration of many of the flying species. Apterous species such as *Cilibe elongata* and *Xylotoles griseus* seem to be subject to chance dispersal, probably during the egg or larval stage. It is difficult to estimate what part accidental transport by man may have played in the dispersal of beetles and other small terrestrial invertebrates to New Zealand's northern offshore islands, but the writer believes it is probably small

Geological History of Hen Island

Brothers (1954) states: "That the North Auckland Peninsula is non-seismic and apparently quite stable has been commented upon by several writers; the area has been free from differential warping movements during Pleistocene time when sea-level oscillations were taking place." He correlates marine-cut and marine-built terraces in the South Kaipara district with the European high sea-levels of interglacial times, i.e. Sicilian (350 feet), Milazzian (220 feet), Tyrrhenian (110 feet), Main Monastirian (50 feet) and Late Monastirian (20 feet). It will be noted that the highest sea-level is 350 feet but "it has been recognised in Europe that gradual withdrawal of the ocean from a position approximately 1200 feet higher than at present began in late Pliocene time and that the glacial period was entered with the Sicilian shore line at the 100 metre level" (Brothers, 1954). Consequently not only most of Hen Island but the majority of the North Auckland Peninsula may have been flooded in late Pliocene times, assuming lack of any substantial tectonic movement at that time.

During the Pleistocene glacial periods, in contrast to the interglacial periods, there is evidence that sea-level was much lower than it is now. The evidence is naturally scanty apart from beach deposits below present sea-level and submarine platforms, which indicate a sea-level of —100 metres during the Last Glaciation. It has been suggested that during one of the earlier glaciations the level was as low as —200 metres (Zeuner, 1950).

There is no good reason to suppose that these low sea-levels did not occur around the coast of North Auckland during the glaciations, especially in view of Brothers' correlations of the Kaipara marine terraces with interglacial periods. Suggate (1958) gives evidence, from well logs in the vicinity of Christchurch, that sea-level in that area was at least 200 feet below present sea-level during the Last Glaciation.

Examination of the Admiralty Chart in the vicinity of Hen Island shows average maximum of 25 fathoms (150 feet) between the island and the mainland, with the depth nowhere greater than 27 fathoms (162 feet). Thus it follows that the Hen was connected to the mainland during the Last Glaciation and almost certainly during earlier glaciations.

During the climax of phase 2 of the Last Glaciation sea-level stood at about —70 metres. The age of this phase is 72,000 years B.P. (Zeuner, 1950), consequently it may be fairly confidently stated that

Hen Island was connected to the mainland 72,000 years ago (and probably much more recently) and at earlier periods of varying duration and not more than 200,000 years apart in any one case. Hen Island is probably of Miocene age, or not appreciably younger (Milligan, 1960).

Origin of the Hen Island Fauna

It is clear from the geological evidence that during Pleistocene times terrestrial animals have had a number of opportunities to migrate to Hen Island via land connections. Land bridges at some time in the past are necessary to account for the presence of the large snails *Paryphanta busbyi* and *Rhytida tarangaensis*. With regard to these species, Milligan (1954) states that "chances of migration other than by land are very unlikely". A previous land connection may be necessary to account for the presence of some of the species of beetles collected, e.g. the two *Ctenognathus* spp. and possibly some of the weevils. Further evidence is required from islands which have definitely not been connected to the mainland in relatively recent times, but it may be fairly confidently stated that most large apterous Carabidae are not subject to chance dispersal across salt water. This subject will be discussed more fully in a later paper.

Among the molluscan fauna there is one known autochthonous endemic species, namely *Rhytida tarangaensis* Powell (1930), while there is no definite example among the known beetle fauna. Insufficient material is available for analysis of geographical variation of beetle species collected, and some of the problems discussed here will not be resolved until such material is available, both from Hen Island and from the mainland opposite. In one case, *Xylotoles griseus*, a species known to show considerable geographical variation, the 9 specimens from Hen Island show little individual variation, and although there are not enough specimens available from the mainland for comparative purposes of a statistical nature, it appears that the Hen Island population has diverged to some extent with regard to such characters as pubescence and punctation. It would be more difficult to explain the absence of geographical variation in isolated populations of such species than the presence of it. It is well known that isolated populations tend to diverge because of the evolution of adaptation to different environments due to selection, and also because of drift and/or the "founder principle" (see Mayr, 1942, 1954; Carter, 1954). A certain period of geographical isolation is essential for speciation to occur (Mayr, 1942, 1954). With regard to Hen Island, periods of isolation have been interspersed with periods of connection with the mainland, allowing unimpeded gene flow between populations in the latter case, but impeding or, in some species, completely stopping gene flow in the former case.

It appears that frequent gene flow across the water barrier between populations of species occurring on Hen Island and on the mainland must occur. It is apparent that most island populations have not diverged even to the extent of subspecific difference from mainland populations.

Thus, it appears that the major part of the Hen Island fauna as it is now constituted has arrived from the mainland in a series of immigrations during Pleistocene times. In most species, frequent exchange of genes with mainland populations has apparently prevented any great degree of divergence of the island populations.

CONCLUSIONS

Further collecting is required on Hen Island and on the mainland opposite for the following reasons:—

(A) The species list of Coleoptera from Hen Island is by no means complete.

(B) Insufficient material is available for statistical analysis and comparison of island and mainland populations.

Study of faunas from the northern offshore islands of New Zealand may be expected to throw additional light on such problems as the processes of geographical speciation and the capacity for dispersal of various species to islands. It is hoped that this paper has indicated some of the problems which require further investigation, and will serve as a basis for future research.

It would appear that the importance of Hen Island as a sanctuary, from the zoological point of view, does not rest on a great number of endemic species. The island provides several types of natural forest habitats free from destructive introduced mammals, in which rare species, while possibly becoming extinct on the mainland, will be able to survive.

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